Successful Mitigation of SO_3 By Employing Dry Sorbent Injection of Trona Upstream of the ESP

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Solvay Chemicals

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Background: SO_3 Plume

- Fine aerosols scatter light
- Low concentrations (10 ppm) visible as blue secondary plume
- Does not disperse readily, touch down risk
- Plume appearance depends on
  - Weather: sunny, clouds, rain, etc.
  - Time of day, angle of sun
- Visible to the Public

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Background – Plume Problem

- **SCR Additions to Control NOx Emissions resulted in unintended increase in SO_3 generation.**
- **High Sulfur Coal, along with SCRs resulted in a highly visible secondary plume.**

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Background – SO_3 Sources

- **SO_3 Generation in Steam Generator: 0.1 to 1.5%**
  - **Oxidation of sulfur during combustion**
  - **Catalytic oxidation of SO_2 by corrosion products**
- **SO_3 Generation in SCR**
  - **Catalytic oxidation of SO_2 to SO_3**
    - Low conversion catalyst: design conversion 1.3%
    - Regular conversion catalyst: design conversion up to 3%
  - **Function of inlet SO_2 concentration, catalyst material, and operating temperature**

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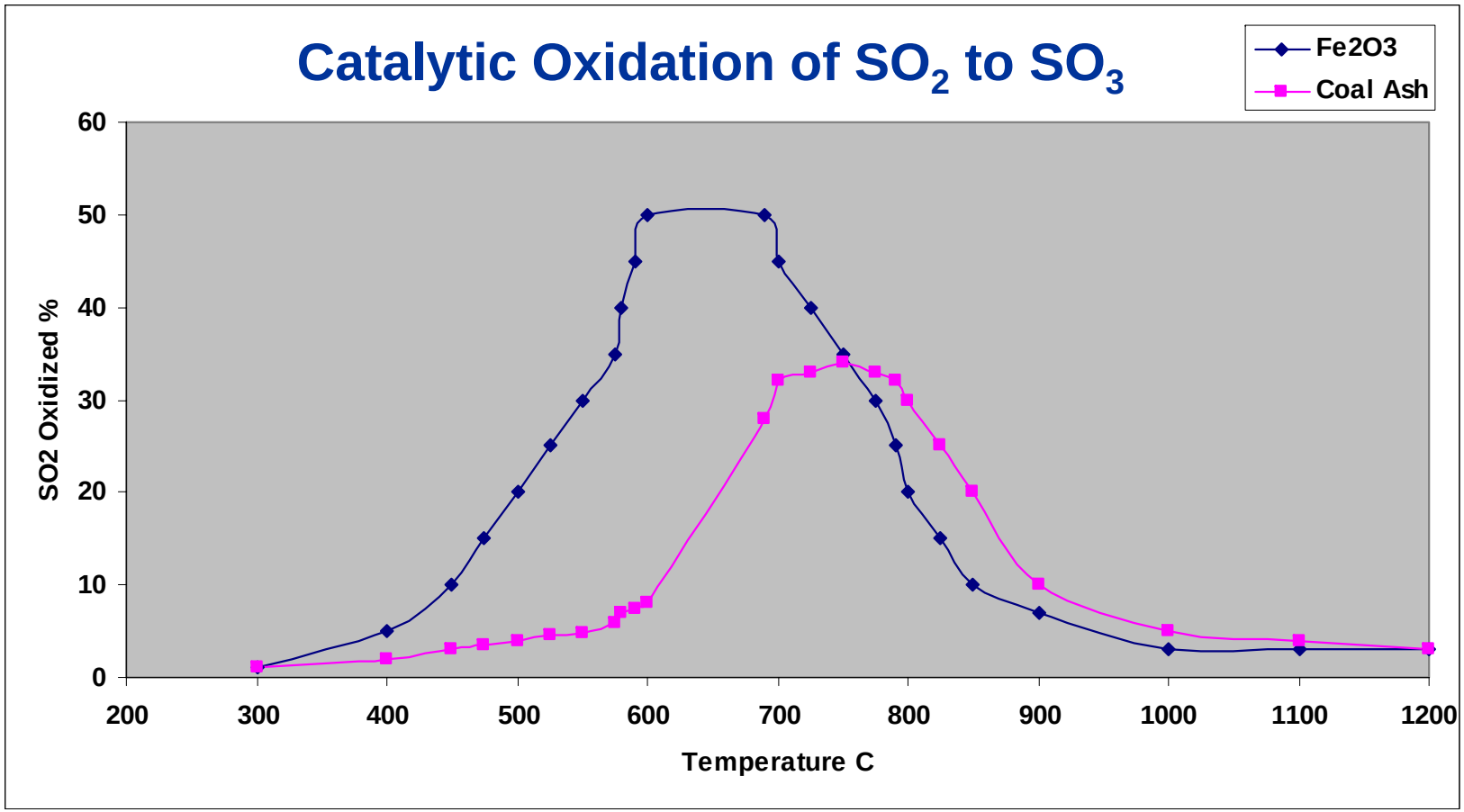
SO_3 Formation



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What is Trona?

- Trona is a ore that is mined underground
- Trona is naturally formed sodium sesquicarbonate
- $Na_2CO_3 \bullet NaHCO_3 \bullet 2H_2O$
- Green River formation
- Numerous beds of Trona
- Contain billions of tons of Trona

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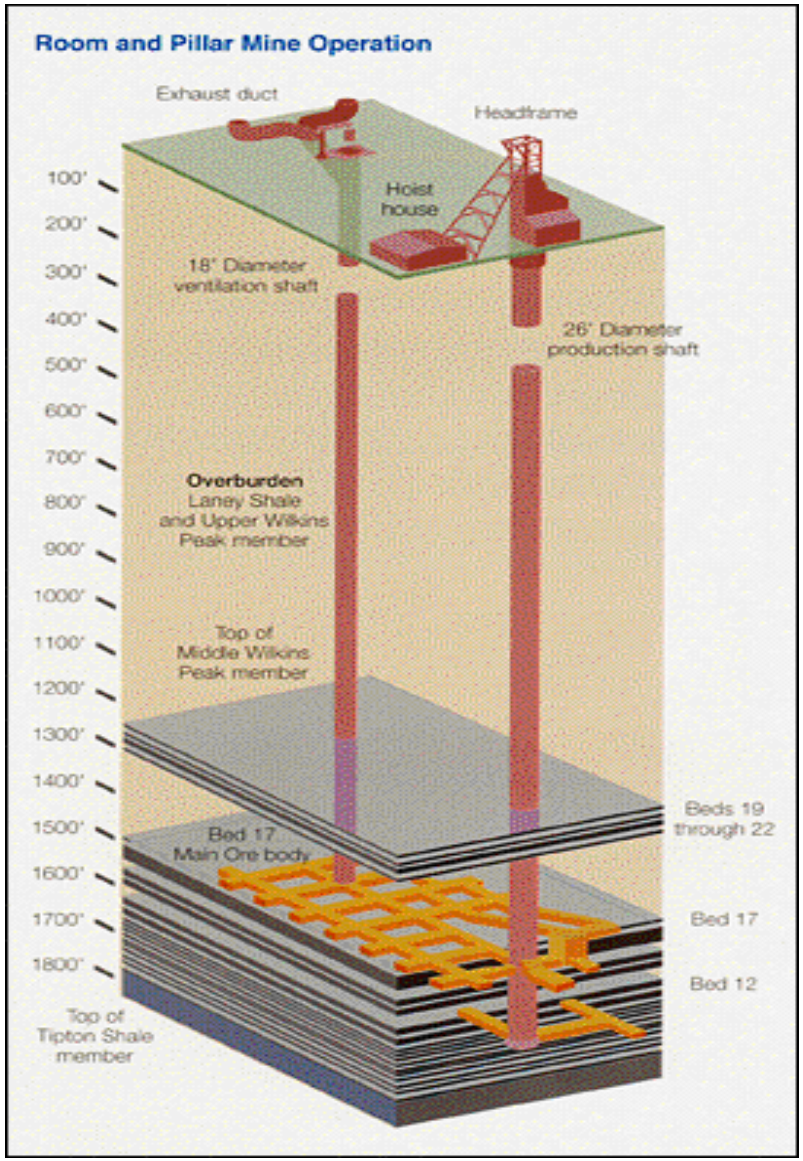
Solvay Minerals Operations

- Solvay Minerals, Inc. Currently Mines Trona Ore at an Approximate Depth of 1500’ (457m)
- 12’ (3.67m) Thick and of Very High Quality
- Provide Ore for Many Years
- Use Both Longwall Mining and Bore Miners



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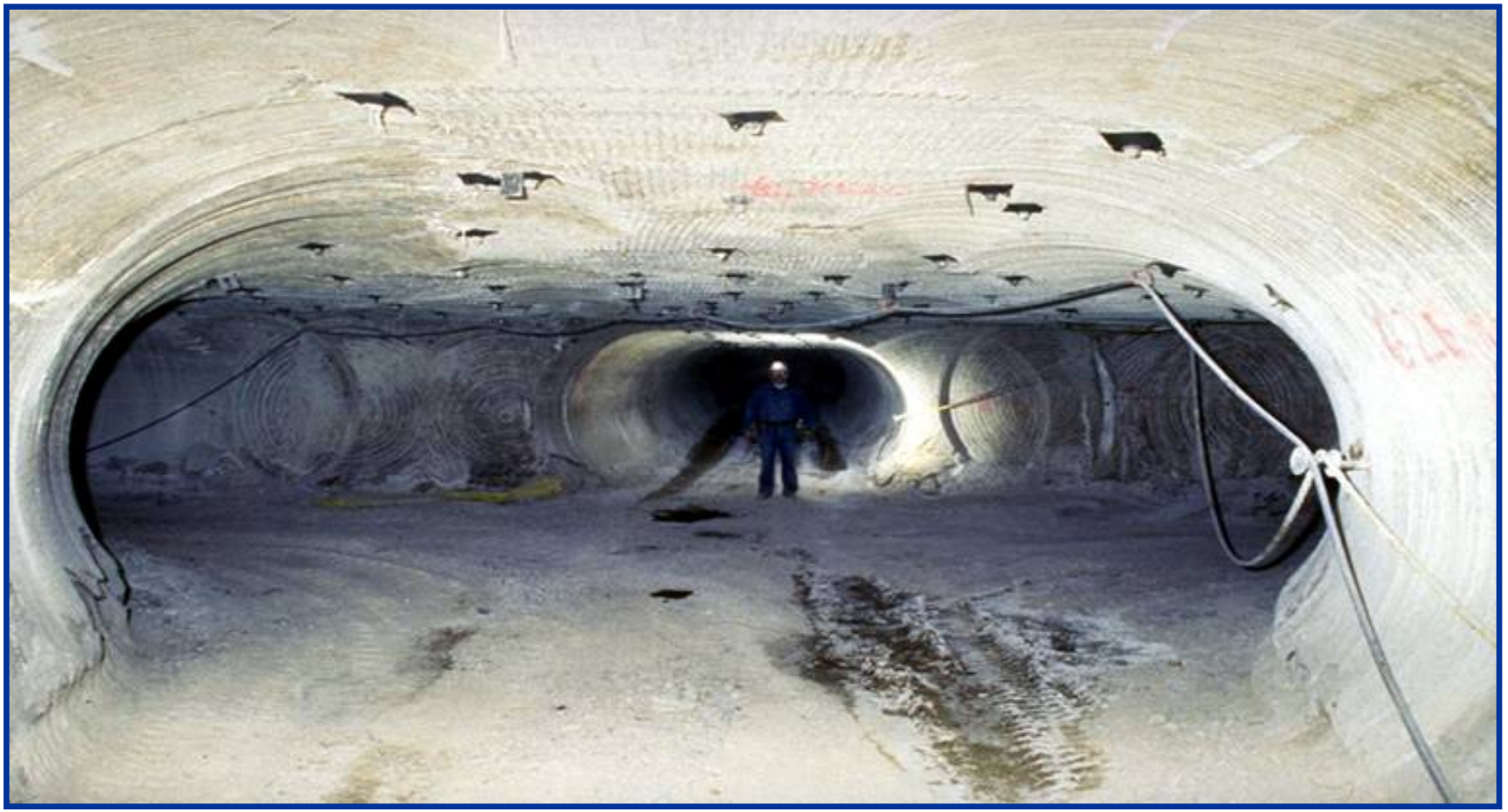
Room and Pillar Mining



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The Surface Plant

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Trona Dry Sorbent Injection (DSI)

- **“Popcorn Effect”**
  - ...5 to 20 times the original surface area
- **$2(Na_2CO_3 \bullet\ NaHCO_3 \bullet 2H_2O) \rightarrow$**

  $3Na_2\ CO_3 + \ CO_2 + 5H_2O$

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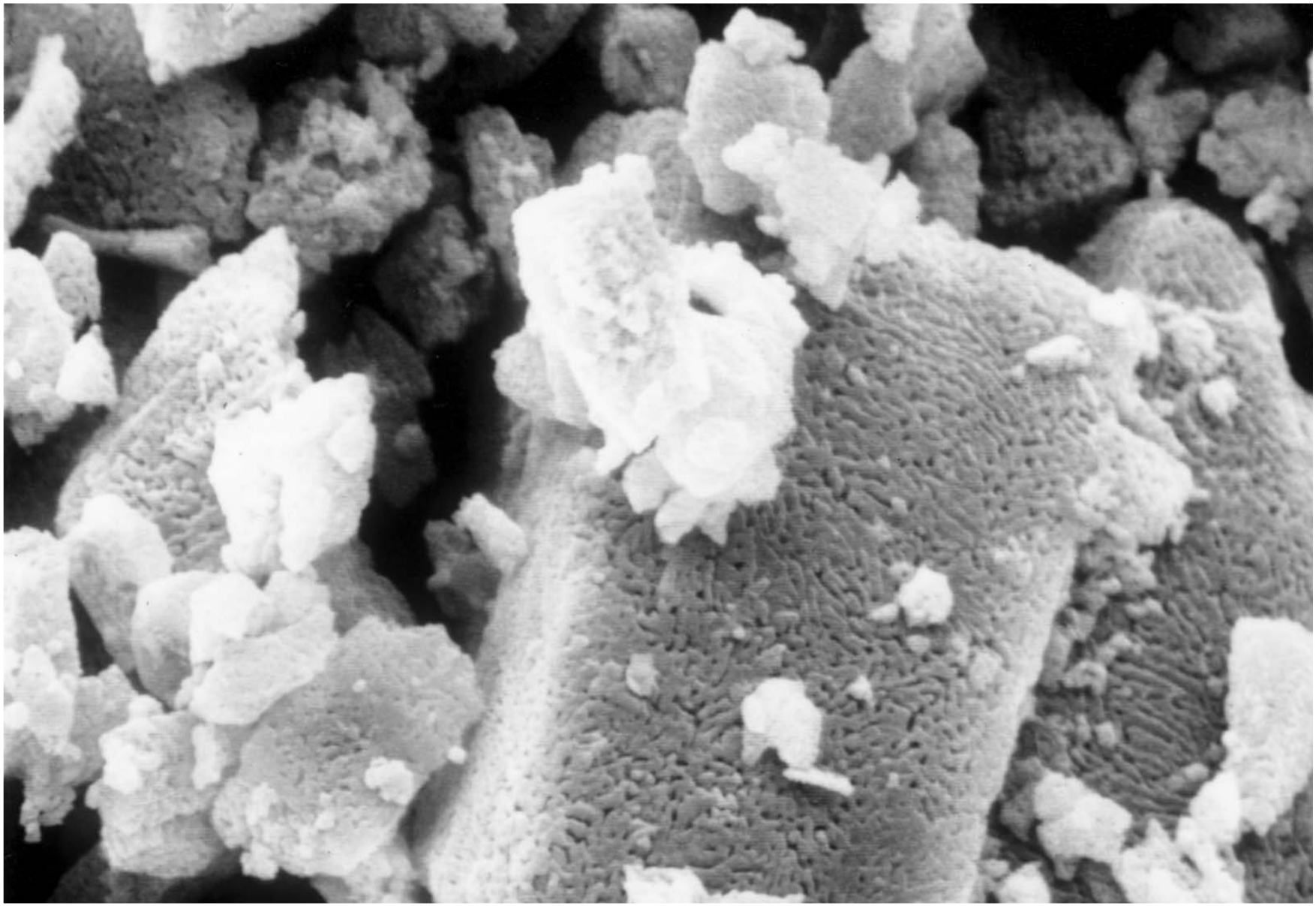
Trona SEM After Calcination



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Trona DSI Chemistry

$$Na_2CO_3 \bullet NaHCO_3 \bullet 2H_2O + 3HCl \rightarrow 3NaCl + 4H_2O + 2\,CO_2$$

$$2(Na_2CO_3 \bullet NaHCO_3 \bullet 2H_2O) + 3SO_2 \rightarrow 3Na_2SO_3 + 4\,CO_2 + 5H_2O$$

$$3Na_2SO_3 + 1.5O_2 \rightarrow 3Na_2SO_4$$

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Parameters Constraints That Affect Sorbent Utilization:

- Sorbent Injection Rate
- NSR (Normalized Stoichiometric Ratio)
- Sorbent Particle Size
- Sorbent Residence Time In The Flue Gas Stream
- Sorbent Penetration And Mixing Within The Flue Gas
- Particulate Control Device Used
- Other Acids

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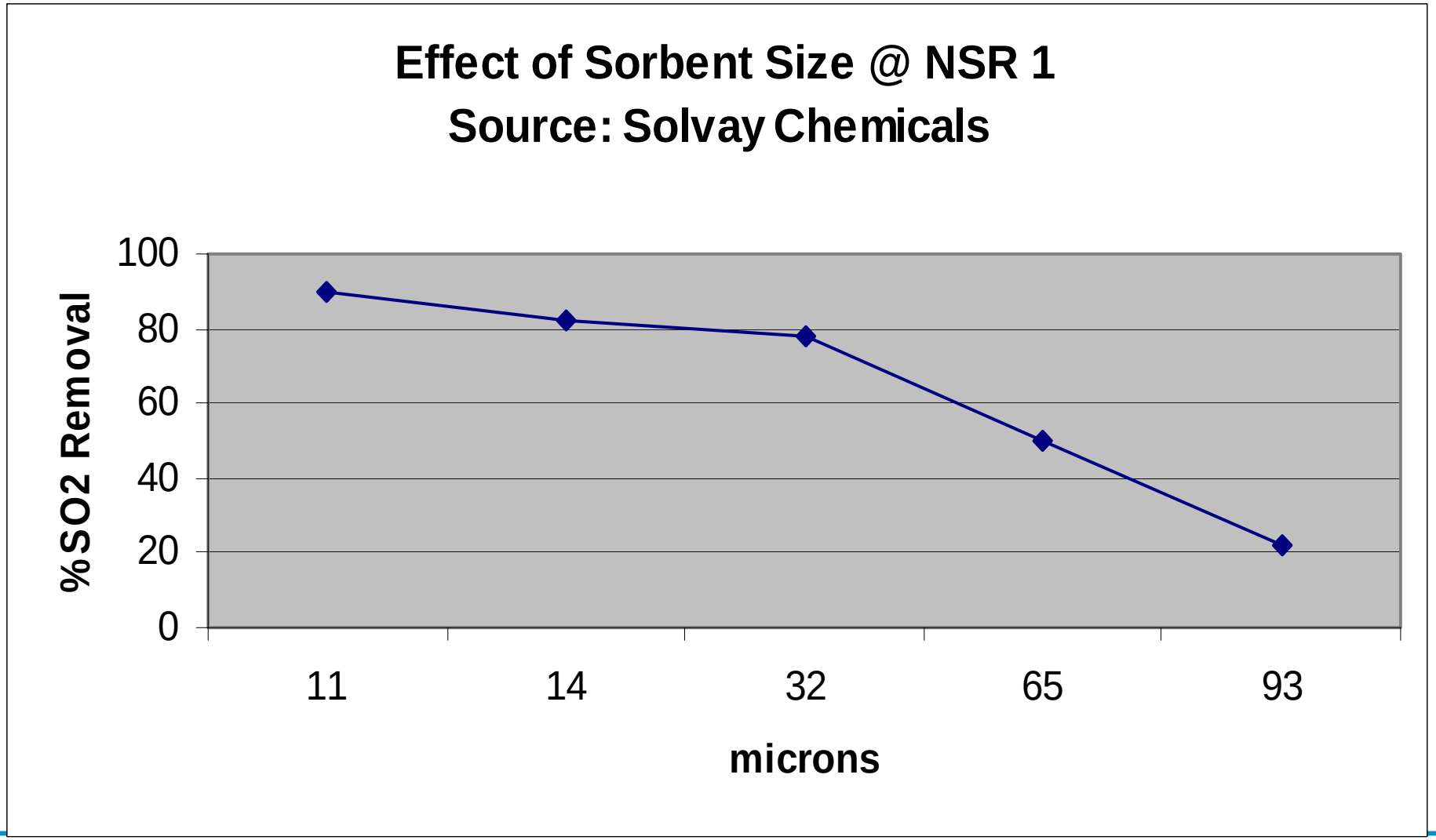
Impact of Particle Size on T200 Performance @325ºF



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Sodium SO_3 Reactions

- $2\ (Na_2CO_3 \cdot NaHCO_3 \cdot 2H_2O) + \text{heat} \rightarrow 3\ Na_2CO_3 + CO_2 + 5\ H_2O$
- $Na_2CO_3 + SO_3 \rightarrow Na_2SO_4 + CO_2$
- $Na_2CO_3 + H_2O + 2SO_3 \rightarrow 2NaHSO_4 + CO_2$
- $NaHCO_3 + SO_3 \rightarrow NaHSO_4 + SO_3$
- $Na_2SO_4 + H_2SO_4 \rightarrow 2NaHSO_4$
- $2NaHSO_4 \rightarrow Na_2S_2O_7$

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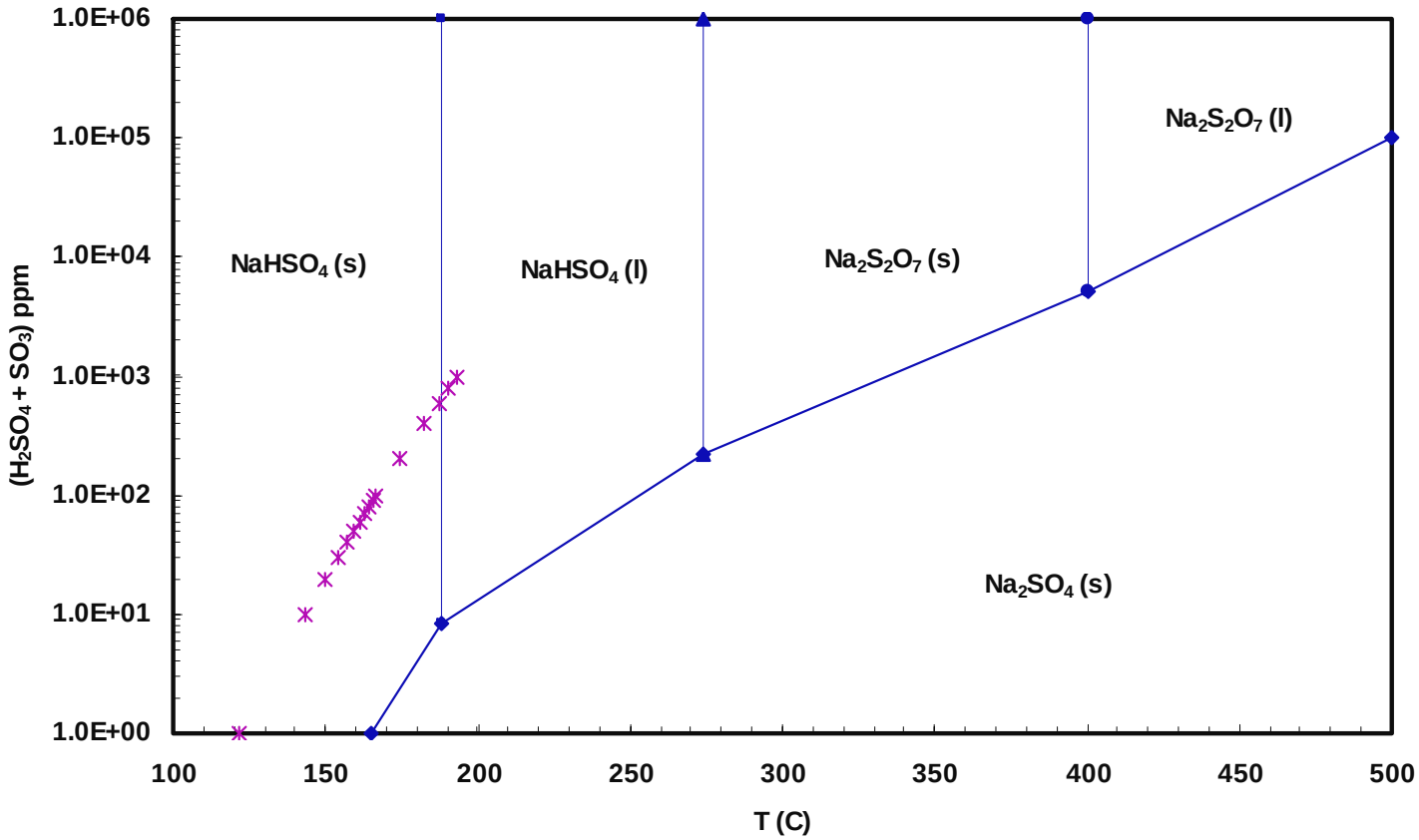
Sodium SO_3 Reactions (continued)



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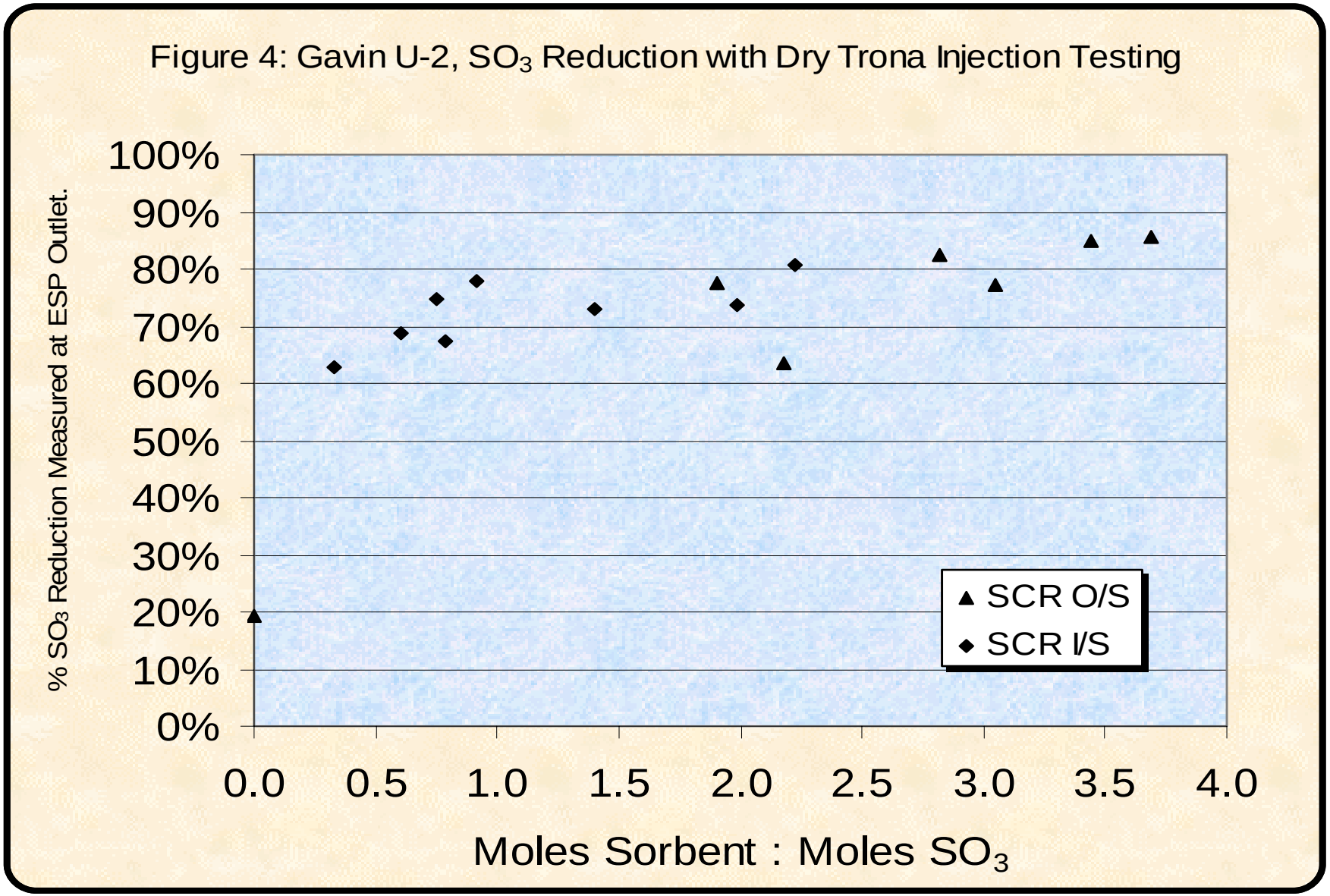
Initial Trial Data with T200 DSI



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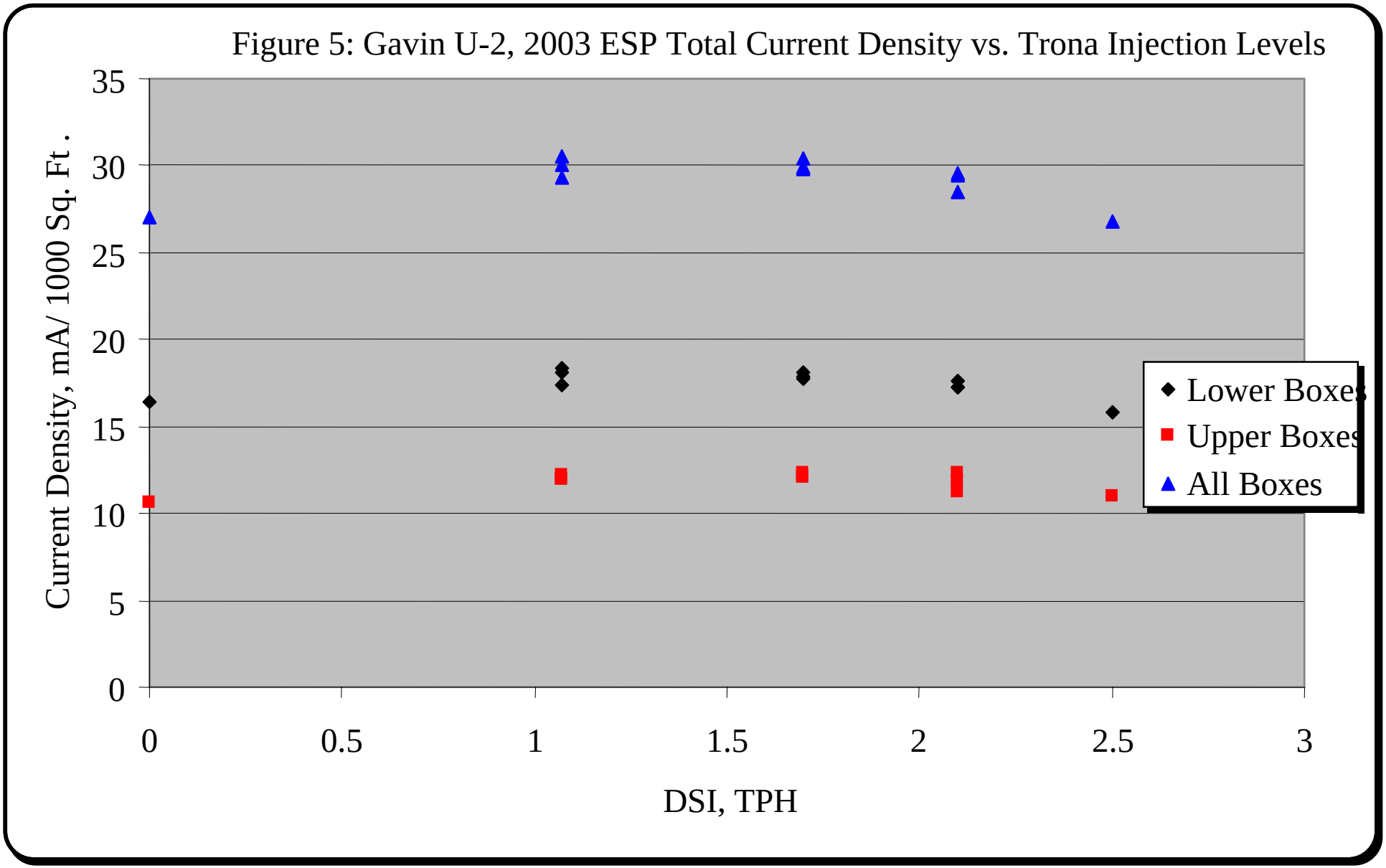
Cold Side ESP Performance Data



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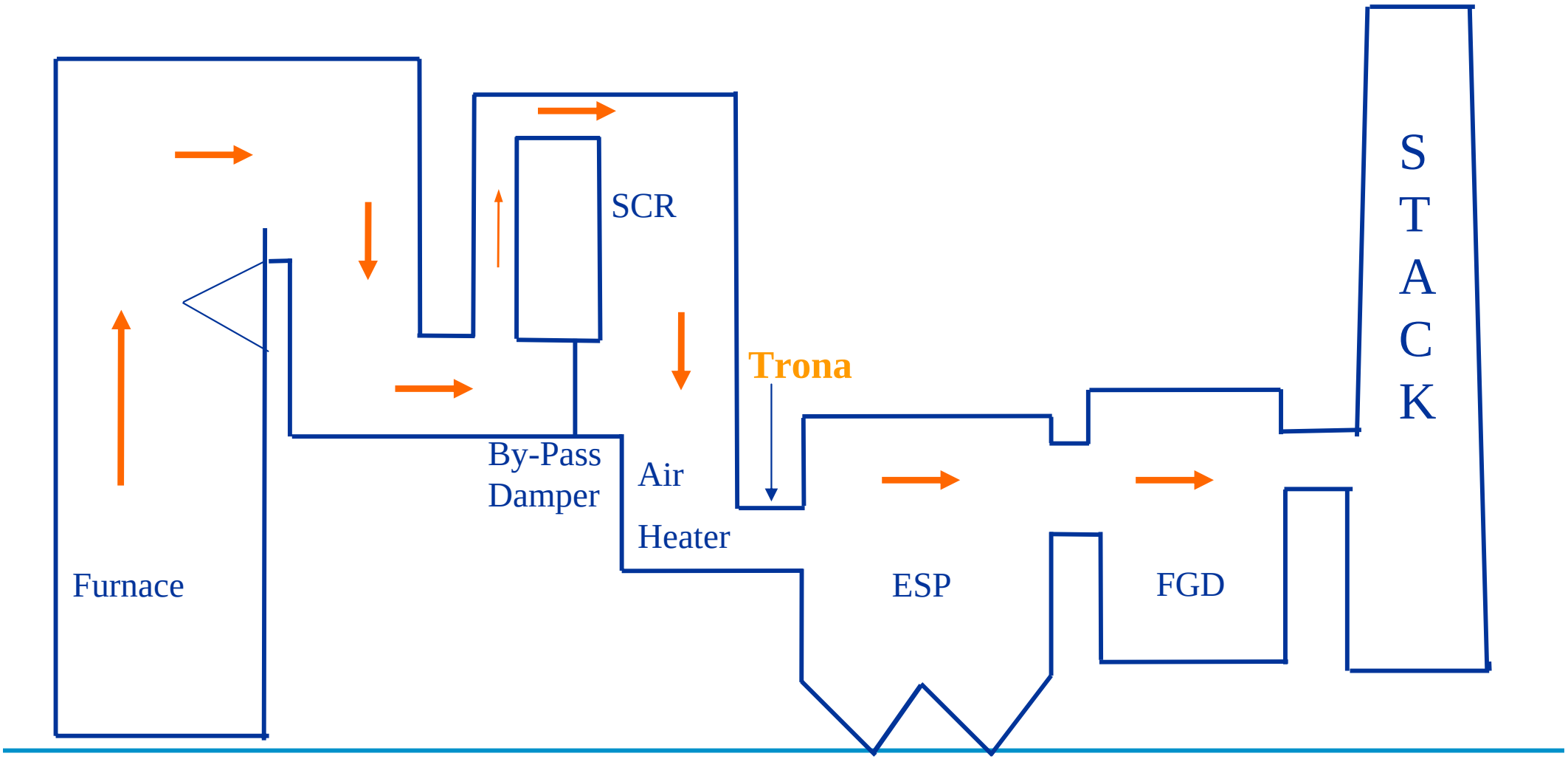
Trona Injection Location



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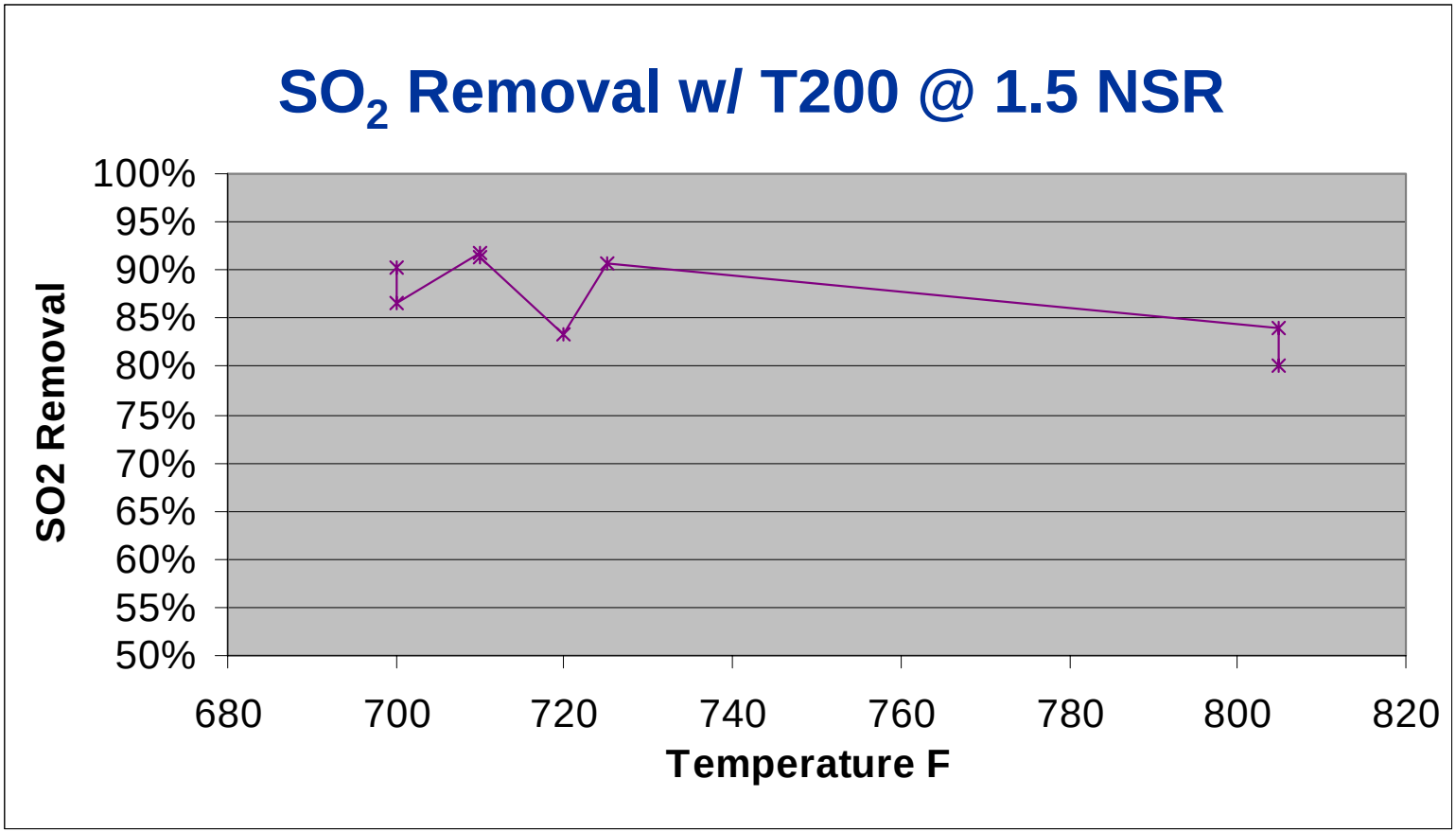
Hot Side ESP Experience @ 800 ppm SO_x



SO_2 Removal w/ T200 @ 1.5 NSR

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ESP Perf Plates Using Sodium Bicarbonate >700ºF

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Perf Plate Before Hot Side of ESP in Previous Slide After Two Weeks of T200 DSI and still “clean as a whistle”

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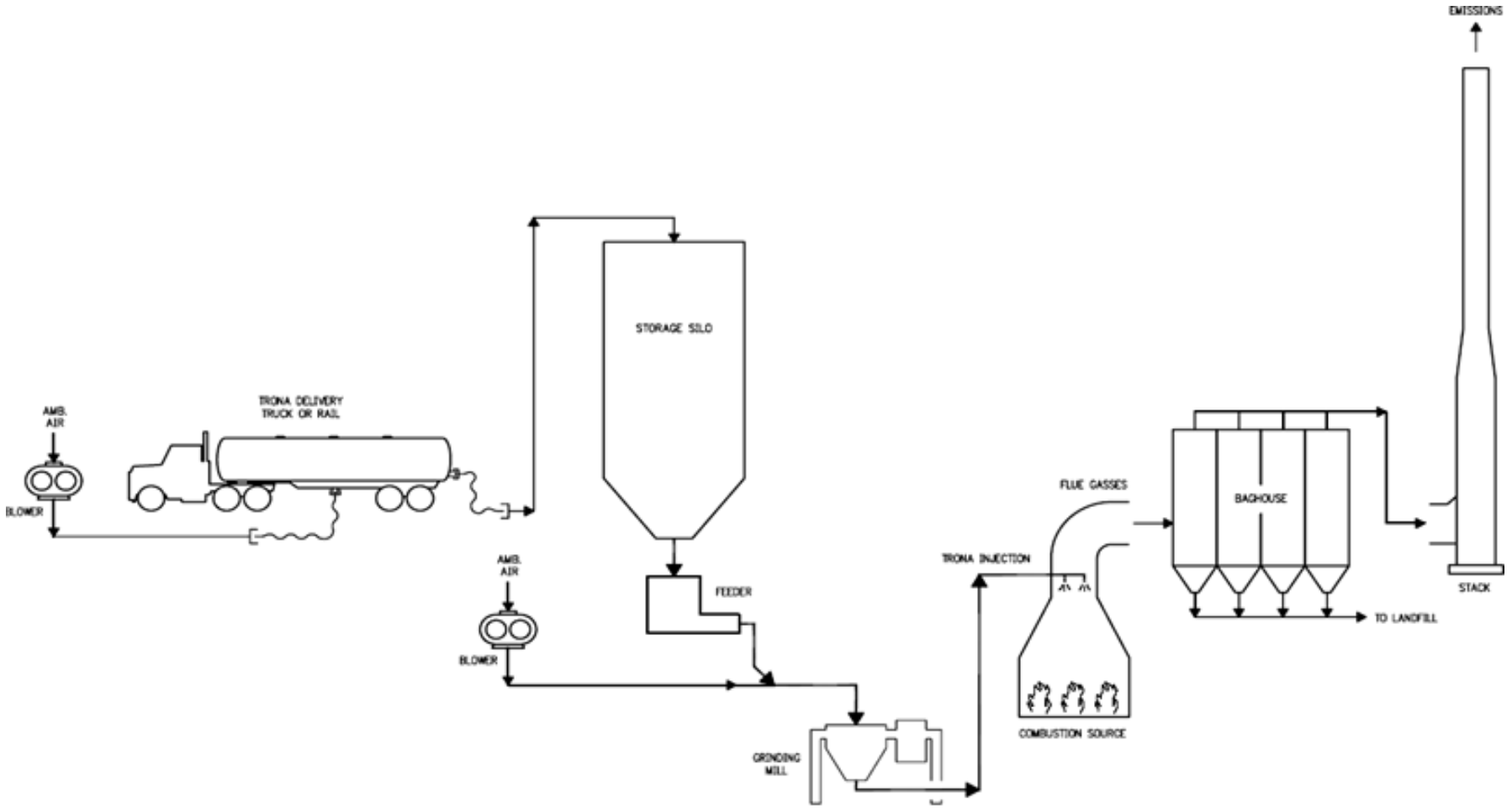
Typical T200 DSI Loading/Storage System



TRONA INJECTION SYSTEM FOR SO2 REDUCTION

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Proven SO_3 Mitigation Systems

Trona Injection At ESP Inlet:

- **Alone Is Sufficient For SO_3 Mitigation, No Visible Plume**
- **Enhances ESP Performance**
- **Capital Costs About The Same As Hydrated Lime**
- **Operating Costs Less Than Lime**
- **No ESP Operational Problems As With Lime**

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The End

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